THE USE OF SAPROXYLIC INVERTEBRATES IN THE SELECTION AND EVALUATION OF AREAS OF RELIC FOREST IN PASTURE-WOODLANDS

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INTRODUCTION

Types of woodlands and forest relics

Traditional woodland management throughout most of Britain has been mainly by coppicing or by a combination of coppicing with maiden or 'standard' trees. Until the 1970s woodland conservation policy in lowland Britain was concentrated towards coppice/coppice-with-standards woodland, these being the most prevalent and best documented types of woodland. Such woods were recognized as being important for their distinctive vascular floras and, in some cases, for their butterflies. Almost all the woodland areas protected by statutory legislation or by the voluntary conservation movement, up to the 1970s, were of this type.

These types of woodland management resulted in little habitat for the fauna and flora particularly associated with the older age-classes of trees which would have occurred in natural (unmanaged) forest in these latitudes (see, for example, Warren & Key, 1991). Evidence of sub-fossil remains from Holocene sites suggest that natural forest with mixed species and age classes of trees survived in some areas until at least 3000 years before the present. A noticeable feature at some of these sites is that there were large, old trees. In the few cases where sub-fossil insect remains have been studied, a varied saproxylic fauna has been recorded in association with evidence of abundant, and often large, trees.

Several of the saproxylic species recorded in Holocene deposits no longer occur in Britain (Girling, 1982). Others have been recorded in the 19th and 20th centuries at a small number of sites characterized by Ratcliffe (1977) in the *Nature conservation review* as 'mixed deciduous woodland: ancient parks and overmature woodland'. The importance of these sites as refugia for a hitherto neglected component of the British flora and fauna was coming to be recognized in the 1970s. At this time, two leading British woodland ecologists, Oliver Rackham and George Peterken, were (largely independently) developing their knowledge and ideas on the role of woodland management history in influencing present-day woodland communities. The 'wood pasture' form of woodland management was recognized by both Rackham and Peterken as an important and distinctive woodland type. Also, Francis Rose had been developing an index of ecological continuity in woodlands, using epiphytic lichens, mainly in areas with large and old trees such as parks and other areas managed as pasture-woodlands.

A survey of the 'mature timber habitat'

In 1975, P.T.H. was commissioned by the then Nature Conservancy Council (NCC) to examine the extent of the 'mature timber habitat' in lowland Britain. The project, which extended over four years, was primarily to identify areas which were known to be of importance, or which may have potential, for saproxylic invertebrates. A later part of the project looked at the problems of management of such sites.

An initial inventory of sites was compiled by P.T.H. in 1975, based largely on published and anecdotal information on the occurrence of saproxylic species and on information about sites with numbers of large, old trees. In 1976 and 1977, he visited about 100 such sites to assess the extent and quality of the habitat potentially available for saproxylic fauna. The project did not include opportunities for systematic sampling at these sites in the way that the complementary surveys of lichens were being made by Francis Rose.

A list of saproxylic invertebrates

As part of the project, the help of several of the most experienced entomologists in Britain was enlisted to compile a list of (mainly) saproxylic species which were regarded as being characteristic of sites already accepted as being rich in saproxylics. This self-fulfilling prophecy was developed with reference to the work of Palm (1959) and related work on other groups, for example Rose's 'index of ecological continuity' (using lichens) (Rose, 1974, 1976), Peterken's 'ancient woodland indicators' (using vascular plants) (Peterken, 1974) and ancient woodland molluscs (Paul, 1979). The list of beetles, published in a report (Harding, 1978), was tested over several years and a revised version, for saproxylic Coleoptera only, was eventually published in Harding & Rose (1986). However, the original list of Coleoptera was compiled from the combined knowledge and experience of A.A. Allen, P.M. Hammond, F.A. Hunter, C. Johnson and P. Skidmore, to whom full acknowledgement must be given.

Previously, comparative lists of a few species and a small number of sites had been compiled by Allen (1966) and Welch & Harding (1974). After the publication of the original list in Harding (1978), several authors have compared or evaluated sites using the list (Hammond, 1979; Welch & Cooter, 1981; Atty, 1983; Garland, 1983).

The 196 species included in Annex 2 of Harding & Rose (1986) was regarded as tentative. They emphasized that the list could only be used to evaluate sites with the following limitations in mind:

1 it is a list of saproxylic species believed to be associated with dead-wood habitats in ancient pasture-woodlands; it is not a list of woodland indicators;
2 it is a national list for lowland Britain in which regional variations can be accommodated to only a limited extent;
3 the ecology and distribution of many species is relatively poorly understood.

INDEX OF ECOLOGICAL CONTINUITY FOR SAPROXYLIC COLEOPTERA

In a paper to a regional meeting of the Royal Entomological Society at Leicester in 1987, K.N.A.A. proposed the development of an 'index of ecological continuity for saproxylic coleoptera' based on the list published in Harding & Rose (1986) (Alexander, 1988).

This index complemented that developed for lichens, but with the added advantages that a larger suite of species was used (195 beetles as against 30 lichens), the list was graded enabling more refined usage and the species are not so sensitive to atmospheric pollution. Disadvantages were that, unlike lichens, beetles are seasonal and many species are difficult to sample. In a recent paper, Hammond & Harding (1991) described the range

of sampling techniques used in conducting qualitative and quantitative surveys of saproxylic invertebrates. More detailed information on techniques (in a tropical context) is given by Hammond (1990).

The 195 saproxylic species (one non-saproxylic was omitted) listed by Harding and Rose were categorized in three groups according to the extent to which they have been consistently recorded from areas of ancient woodland with continuity of dead wood habitats. For example Group 1 species were regarded to be the most faithful to such sites and Group 3 those which could occur widely in wooded land.

K.N.A.A. proposed that these three groups should form the basis of a scoring system, on a presence/absence basis, to interpret lists of species recorded at a site and to provide an evaluation of the site based on the species of saproxylic Coleoptera recorded. The value of each of the three groups, as related to the others, is subjective, but Group 1 species were regarded to be more important (for reasons of scarcity and apparent faithfulness to known ancient pasture-woodlands) than those in Group 3 and therefore merit a higher score. Thus the presence of a Group 1 species scores 3, a Group 2 species scores 2 and a Group 3 species scores 1.

A decision was made to exclude historical records in the calculation of the index and only records since 1950 have been used. The index is intended to be used in evaluation for nature conservation and therefore should reflect the current and recent past interest of the sites being considered. Many of the anecdotal records available for sites are historical. Including such records would bias the index to select sites which were important in the early 20th century, but many of which subsequently have been destroyed or severely degraded as relics of forest with old trees. The cut-off date for records to be used in the index was settled at 1950, following the example of the NCC's Invertebrate Site Register.

The general paucity of records for many sites, and the absence of any systematic attempt to survey the beetles of a large number of sites, inevitably means that comparisons of one site with others are subject to considerable bias. The original index values calculated in 1987 have been subject to ongoing revision as new records for sites have been incorporated and as completely new sites have been surveyed. However, it is possible to place a site on a scale of importance relative to other sites providing the above caveats are accepted. Table 1 is a list of the most important pasture-woodland sites in lowland Britain assessed using the 'index of ecological continuity' (IEC).

Index values of 20 or more appear to identify the most important sites of a national series, but this threshold may need to be raised as more survey results become available.

The sites listed in Table 1 should be considered as priority areas for conservation measures to protect and perpetuate the habitat.

GEOGRAPHICAL DISTRIBUTION OF SITES IN BRITAIN

The list of sites in Table 1 has a clear bias towards the lowlands and the south-east. Ecological considerations suggest that this bias reflects the probable range of the largely thermophilous species included in the assemblage, but recorder bias is almost certainly present; few sites in Wales, the south-west and northern England have been surveyed in detail. Based on pre-1950 records, sites such as Gibside (Tyne and Wear) and Shute Park (Devon) have IEC values of 26 and 31 respectively. However, important sites such as Moccas Park (Hereford/Worcester) and Duncombe Park (North Yorkshire) are on the fringes of this lowland/south-eastern area.

Regional indices, based on the national index, would provide greater sensitivity in the assessment of sites. Garland (1983) proposed such a regional index, based partly on Harding (1978), but did not distinguish clearly between the specialized saproxylic species and general ancient woodland indicators. Further consideration should be given to either regional indices or to regional weighting of the national index, but the collection of more data (new sites, systematic surveys by specialists, resurvey of sites omitted from the present list due to the age of the records, collation of unpublished data) are probably a more urgent priority.

Table 1. The most important national sites for the saproxylic Coleoptera of ancient woodlands, especially pasture-woodlands, graded using the index of ecological continuity (IEC)

Site Name	Area* (Ha)	Number of recorded species in each grade**			Calculated IEC
		1	2	3	
Windsor Great Park & Forest	710	48	22	45	233
New Forest	3800	25	22	64	183
Moccas Park	140	23	12	36	129
Epping Forest	1150	10	11	47	99
Sherwood Forest	525	14	9	34	94
Richmond Park	940	10	9	26	74
Burnham Beeches	453	3	13	31	66
Clumber Park	1500	6	8	31	65
Calke Park	80	6	6	34	64
Arundel Park	109	7	6	30	63
Knole Park	383	6	9	26	62
Wytham Woods	230	2	10	34	60
Monks Wood	157	5	5	28	53
Staverton Park	85	5	5	24	49
Bredon Hill	-	8	5	13	47
Dunham Massey Park	78	2	6	26	44
Kedleston Park	819	3	3	27	42
Blenheim Park	900	7	3	13	40
West Walk, Bere	-	2	4	25	39
Duncombe Park	78	3	2	24	37
Attingham park	c.150	3	4	18	35
Buxted Park	c.90	4	3	17	35
Box Hill	-	1	4	24	35
Grimsthorpe Park	92	1	3	26	35
Icklingham Plains	c.180	5	2	15	34
Hatfield Forest	360	4	4	14	34
Ashtead Common	c.200	6	4	7	33
Donington Park	c.120	4	3	15	33
Savernake Forest	930	5	3	12	33
Forest of Dean	c.8000	2	2	23	33
Thorndon Park	c.200	1	3	23	32
Stockton's Wood	c.15	1	3	19	28
Brampton Bryan Park	175	1		25	28
Lullingstone Park	260	1	5	15	28
Cirencester Park Woods	c.800		3	22	28
Rockingham Castle Park	60	1	3	18	27
Shrubland Park	80	3	4	10	27
Croft Castle	c.400	1	2	19	26
Chatsworth Park	630	3	2	12	25
Lower River Weaver Woods	c.100	2	1	16	24
Nettlecombe Park	c.80		3	17	23
Dinefwr Deer Park	97			23	23
Thorne Moors	-		2	19	23
Harewood Forest	650	4	1	8	22
Castor Hanglands	c.100	1	1	16	21
	70		2	16	20

* Approximate areas, where known. ** Graded in Harding & Rose (1986)

A EUROPEAN PERSPECTIVE

In 1980, the Council of Europe set up a Consultants' Group to identify projects related to invertebrate conservation which might be supported by the Council. A project on saproxylic invertebrates was selected to provide insight into the decomposer sector in ecosystems. An advantage of this project was that additional information on the remnants of the natural forests of Europe would be acquired.

The project began in 1982 with the establishment of criteria for use in the selection of the saproxylics to be used as bio-indicators of site quality. The criteria, listed by Speight (1989), resulted in a list of 33 insect species. This list was soon abandoned because the species were already so localized within their European range that only a few forests would be identified as a result, although those sites would probably have been the *crème de la crème*. None of the species listed is known to have occurred in Britain in recent times. Based on the original criteria, a revised and considerably expanded list of about 200 species of Coleoptera, Diptera, Hemiptera and Hymenoptera was prepared (Speight 1989, Annex 1). Using this list of species and a simple questionnaire, Speight sought information on the sites regarded by national specialists to be the most important for these and similar species. Four relic deciduous forest sites were selected from the information collated by Speight: Windsor, New Forest, Epping Forest and Moccas Park. The Caledonian pine forest at Abernethy was also included.

CONCLUSIONS

The evaluation of sites for wildlife conservation has traditionally been based on botanical and ornithological assessments. In the case of relic woodlands formerly or currently managed by the wood-pasture system, vascular plants (primary producers) and birds (secondary producers) are unlikely to provide meaningful measures of the importance of such sites. Decomposers, such as saproxylic Coleoptera, are especially associated with such relic areas and provide a more reliable measure of the biodiversity of sites. A simple method to assess deciduous pasture-woodlands in lowland Britain has been developed which uses available data, often derived from the biological recording activities of a small group of specialists. More data are needed to develop and improve the present index of ecological continuity of saproxylic Coleoptera, but the preliminary results show that it is possible to identify and rank sites at a national level. Hammond & Harding (1991) discussed ways in which the present list of species could be improved (for example by the addition of some species and the omission of others). They also proposed that lists of rare non-saproxylic woodland Coleoptera could be compiled for use in the evaluation of sites.

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